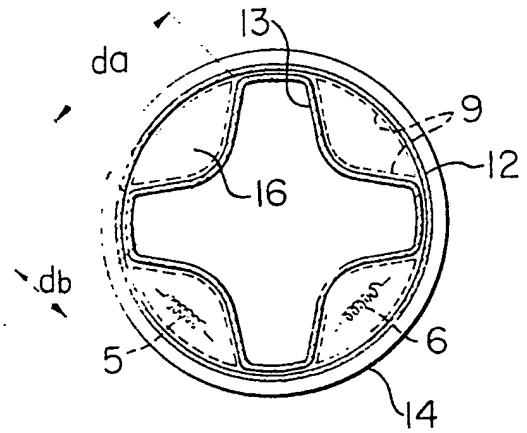
(12) UK Patent Application (19) GB (11) 2 092 823 A

(21) Application No 8202107
(22) Date of filing 26 Jan 1982
(30) Priority data
(31) 56/016617
(32) 5 Feb 1981
(33) Japan (JP)
(43) Application published
18 Aug 1982
(51) INT CL³
H01J 61/33
(52) Domestic classification
H1D 12B13Y 12B1 12B47Y 12B4 35 5G 9D 9Y
(56) Documents cited
None
(58) Field of search
H1D
(71) Applicant
Matsushita Electronics Corporation,
1006 Oaza Kadoma,
Kadoma-shi,
Osaka,
Japan
(72) Inventors
Haruo Yamazaki,
Hidezoh Akutsu,
Yoshiro Ogata,
Kazuo Murata
(74) Agents
Mathisen, Macara and Co.,
Lyon House,
Lyon Road,
Harrow,
Middlesex,
HA1 2ET

(54) **Fluorescent Lamp**

(57) In a fluorescent lamp with an outer envelope (12) having generally a part spherical, part cylindrical configuration and an inner bulb (13) nested inside to define a continuous zig-zag groove (16) forming the discharge path, the maximum width of the bends of the zig-zag groove (16) is narrower than the maximum width of the straight portions thereof, to improve uniformity of illumination. (Fig. 4, not shown). A phosphor (9) coats the wall of the discharge path. Electrodes (5 and 6) are mounted at opposite ends of the discharge path. An ultraviolet radiation-emitting discharge gas consisting of mercury vapour and a rare gas fill the discharge path. The open ends of the outer envelope and the inner bulb are gas-tightly sealed together.

FIG. 3B



GB 2 092 823 A

The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

'1

FIG. IA

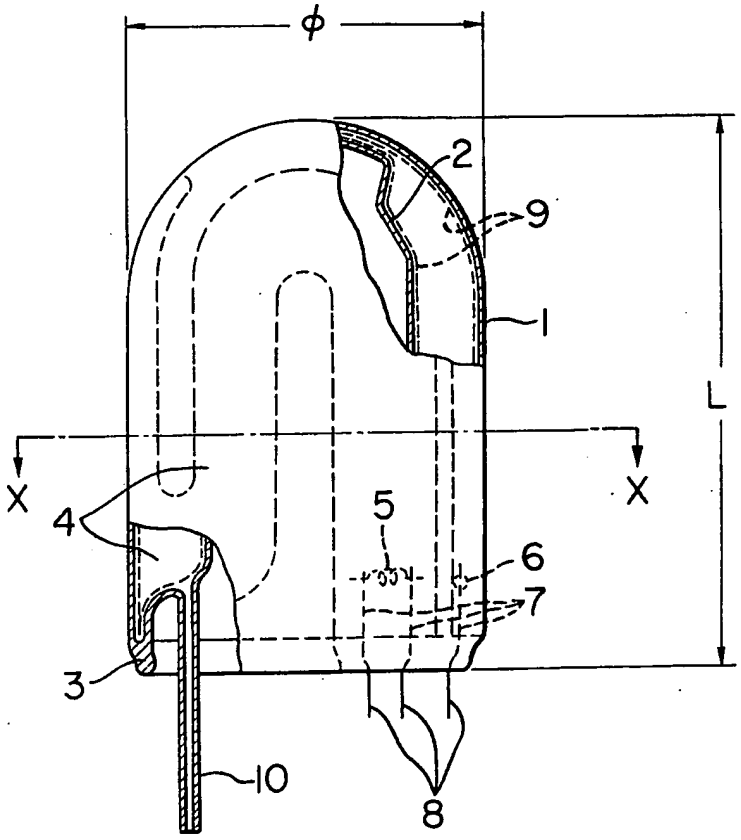


FIG. IB

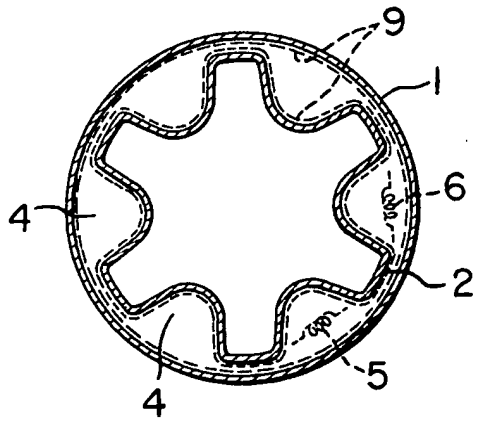


FIG. 3A

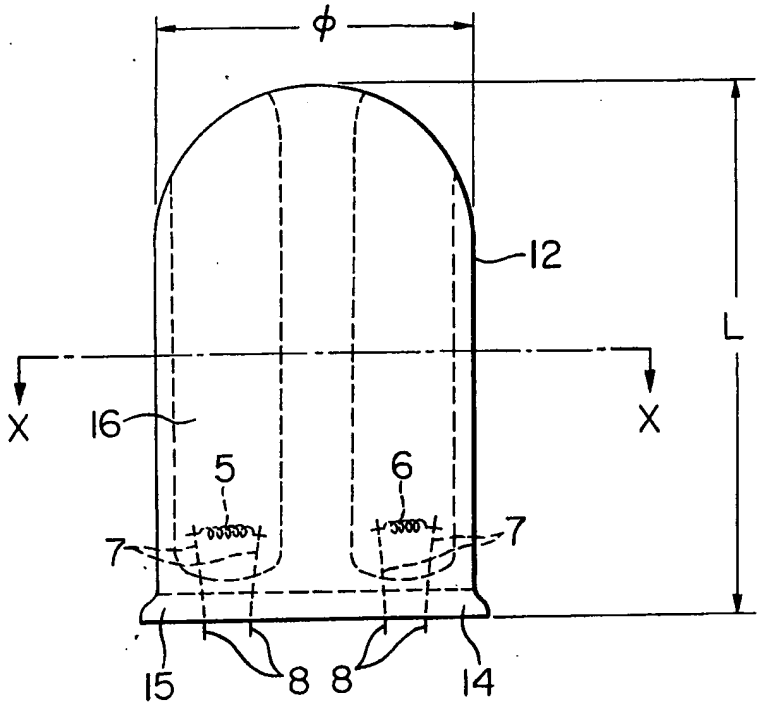


FIG. 3B

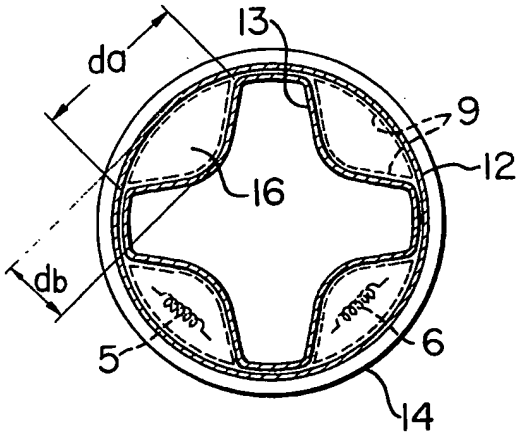


FIG. 2

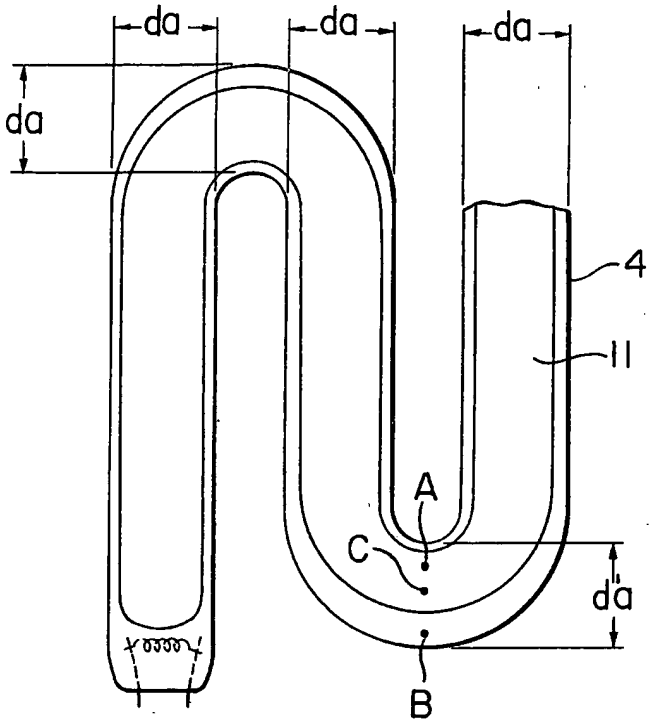
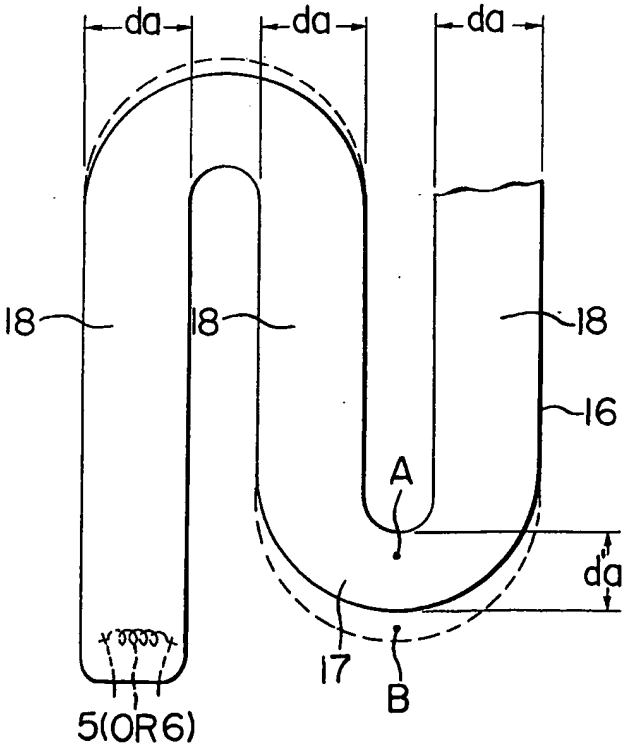


FIG. 4



45

FIG. 5

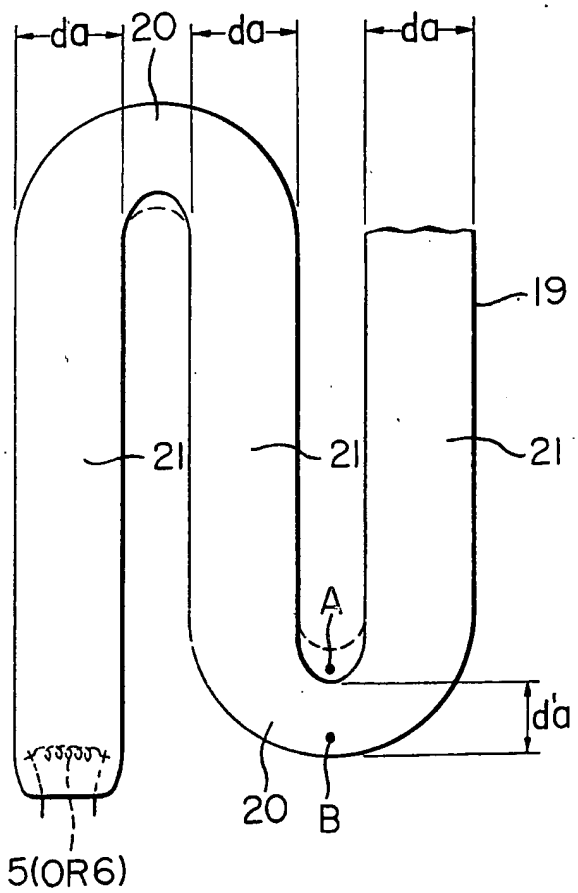


FIG. 6

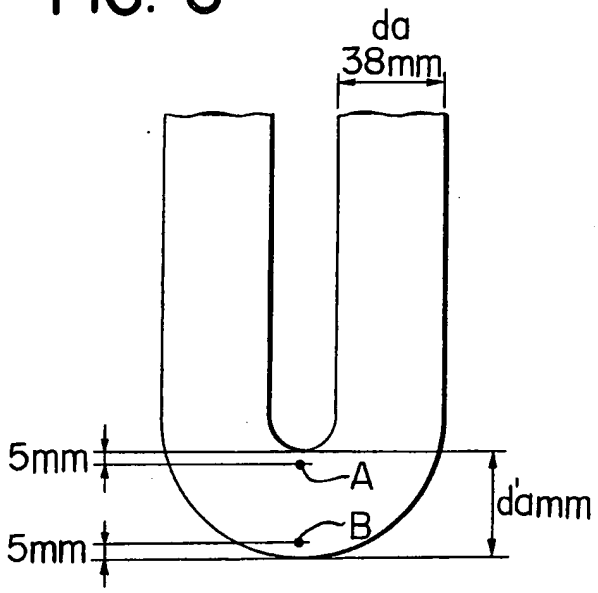
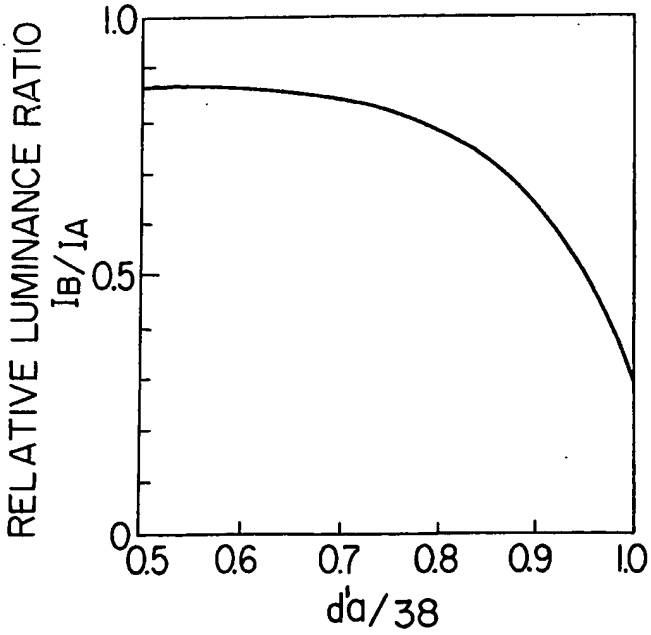

da
38mm
5mm
A
d'amm
5mm
B

FIG. 7


RELATIVE LUMINANCE RATIO
IB/IA
1.0
0.5
0
0.5
0.6
0.7
0.8
0.9
1.0
d'a/38

SPECIFICATION

Fluorescent Lamp

Background of the Invention

The present invention relates to a fluorescent lamp.

Incandescent lamps are easy to use and are compact in size and produce high luminance. Therefore, they are widely used for accentuated illumination in home and shops. However, from the standpoint of energy savings, their low efficacy is a serious problem and, therefore, there has been an increasing demand for small-sized discharge lamps which can be used instead of incandescent lamps and which can exhibit high efficacy.

In an attempt to meet such demand, the same applicant proposed a fluorescent lamp as disclosed in U.S. Patent No. 4,095,135 (British Patent No. 1,578,246). This fluorescent lamp not only exhibits a high efficacy but also have all the merits of the incandescent lamps such as compactness. Briefly stated, the fluorescent lamp has generally a spherical or dome-shaped configuration and comprises a spherical or dome-shaped outer bulb and an inner bulb formed with a zig-zag groove over the outer wall surface thereof and inserted into the outer bulb in predetermined nested relationship so as to define a zig-zag discharge path therebetween. The discharge path has a substantially circular or elliptical cross sectional configuration and is filled with an ultraviolet radiation-emitting discharge gas consisting of mercury vapor and a rare gas or a rare gas mixture for producing ultra-violet radiation. A phosphor is applied to the inner wall surface of the outer bulb and/or the outer wall surface of the inner bulb.

The inventors made extensive studies and experiments to further improve the fluorescent lamp of the type described and found out that it has some problems when used. A first problem is that the luminance distribution is not uniform at the bends of the groove or discharge path. The fluorescent lamp of the type described must function not only as a light source but also as an indoor decoration. Thus, the non-uniform luminance distribution is the most serious defect of the prior art fluorescent lamp.

Summary of the Invention

An object of the present invention is to provide fluorescent lamps of the uniform luminance distribution.

A fluorescent lamp, according to the present invention, has a lamp envelope comprising an outer bulb having generally a spherical or a partially spherical or a cylindrical configuration and an inner bulb with a zig-zag groove formed over the outer wall surface thereof so that when the inner bulb is inserted into the outer bulb in predetermined nested relationship, a zig-zag discharge path is defined between them. A radiation-emitting discharge gas is filled in the zig-zag discharge path and electrodes are disposed at the ends, respectively, thereof. Not only the open end portions of the outer and inner bulbs can be gas-tightly sealed together but also the lead-wires which also serve to support the electrodes at the ends of the discharge path can be also gas-tightly sealed.

According to the present invention, the maximum width of the bends of the groove is narrower than the maximum width of the straight portions thereof.

The above and other objects, effects and features of the present invention will become more apparent from the following description of preferred embodiments thereof taken in conjunction with the accompanying drawings.

Brief Description of the Drawings

Fig. 1A is a side view, partly broken away, of a prior art fluorescent lamp;
Fig. 1B is a sectional view thereof taken along the line X—X of Fig. 1A;
Fig. 2 shows the development of part of the groove thereof;
Fig. 3A is a side view, partly broken away, of a first embodiment of the present invention;
Fig. 3B is a sectional view thereof taken along the line X—X of Fig. 3A;
Fig. 4 shows the development of part of the groove thereof;
Fig. 5 shows the development of the groove of a second embodiment of the present invention;
Fig. 6 shows a groove used in an experiment; and
Fig. 7 shows the results of the experiment.
Same reference numerals are used to designate similar parts throughout the figures.

Detailed Description of the Prior Art

In Fig. 1 is shown a fluorescent lamp disclosed in the above-mentioned U.S. Patent No. 4,095,135. An inner bulb 2 made of a transparent glass is nested in an outer bulb 1 which is made of the same glass and is partially or completely spherical or cylindrical in shape. The open ends of the outer and inner bulbs 1 and 2 are air-tightly sealed together to form a sealed portion 3. The inner bulb 2 is formed with a continuous zig-zag groove 4 which defines a discharge path and electrodes 5 and 6 are disposed at the ends thereof and supported by lead-in wire pairs 7 which in turn are connected to external lead wires 8. The inner surface of the outer bulb 1 and the outer surface of the inner bulb 2 are

coated with phosphor layers 9. The space defined between the outer and inner bulbs 1 and 2 is evacuated through an exhaust tube 10 and filled with a rare gas such as neon, argon, krypton or xenon.

In order to improve the fluorescent lamp of the type described, the inventors made extensive studies and experiments and found out that there are some problems left to be solved.

Fig. 2 shows the development of a partial length of the groove or discharge path 4. Reference numeral 11 denotes a discharge arc. A first problem is that the luminance distribution is not uniform at the bending portions of the groove or discharge path 4. More specifically, the luminance at the inner point A is by far higher than that at the outer point B. Especially the sharp drop in luminance at the outer portions at the bends of the groove or discharge path 4 adjacent the sealed portion 3 gives the incandescent lamp a poor and displeasing outer appearance. The fluorescent lamp of the type described also must serve as a decoration, so that the poor and displeasing outer appearance is a fatal defect in practice.

Description of the Preferred Embodiments

The inventors investigated the causes for causing the non-uniform luminance distribution as described above and found out that since the zig-zag discharge path is so designed as to be as the shortest possible, the arc is deflected toward the inner side at the bends of the discharge path with the resultant non-uniform luminance distribution. The inventors also found out that such arc deflection can be remedied by making the width of the bends of the discharge path shorter than the maximum width of the straight portions thereof. With such discharge path, the luminance distribution can be remarkably improved as will be described in detail below.

Referring first to Figs. 3A and 3B, an outer envelope 12 is made of a transparent glass and is partially or completely spherical or cylindrical in shape. An inner bulb 13 which is made of the same glass is nested into the outer bulb 12, whereby a lamp envelope is provided. The open end of the outer bulb 12 is flared as shown at 14 and this flared end portion 14 is filled with glass frit (not shown). The glass frit is heated and melted to seal between the open ends of the outer and inner bulbs 12 and 13, whereby a sealed portion 15 is formed. The inner bulb 13 is formed with a continuous zig-zag groove 16 which defines a discharge path. As best shown in Fig. 3B, the groove has four straight portions. Electrodes 5 and 6 are disposed at the ends of the groove 16 and supported by lead-in wires 7 which in turn are connected to external lead wires 8. It is preferable that the portions of the lead-in wires 7 which are extended through the sealed portion 15 are coated with glass and that the lead-in wires 7 are separated from each other by means of a glass bead. The inner surfaces of the outer bulb 12 and the outer surfaces of the inner bulb 13 which define the discharge path 16 are coated with layers of phosphor 9. Alternatively, either of the inner surface of the outer bulb 12 or the outer surface of the inner bulb 13 may be coated with layers of phosphor 9. The envelope is filled with a rare gas such as neon, argon, krypton or xenon.

Referring to Fig. 4, the maximum width d'_a of the bend 17 of the groove 16 is narrower than the maximum width d_a of the straight portion 18. The groove 16 has the same depth d_b throughout its length.

As described above, the maximum width d'_a of the bend 17 of the groove 16 is narrower than the maximum width d_a of the straight portion 18 so that the uniform luminance can be maintained at the bend. In addition, the outer side of the bend 17 is narrowed so that the lamp becomes compact in size.

In Fig. 5 is shown a second embodiment of the present invention; that is, the development of a part of a groove 19. The upper side of the bend 20 with a downward concave; that is, the bend remote from the electrodes 5 and 6 (see Fig. 3) is narrowed while the lower side of the bend 20 with an upward concave; that is, the bend close to the electrode 5 or 6 is narrowed. (The development of the prior art groove 4 is shown by the broken lines). Therefore, the maximum width d_a becomes wider than the maximum width d'_a of the bend 20. The second embodiment can exhibit the same effects as the first embodiment. According to the second embodiment, if the envelopes are same in size, the effective length of the discharge path can be increased so that the ratio of the energy loss due to the electrode heating to the watt input can be reduced and consequently the lamp efficacy can be increased.

The inventors fabricated some fluorescent lamps embodying the present invention and investigated the luminance distributions at the bends. It was found out that it is preferable that the maximum width d'_a at the bend with an upward concave be less than 0.85 times the maximum width d_a of the straight portion. The groove used in the experiments is shown in Fig. 6 and Fig. 7 shows the results of the experiments. That is, the relative luminance ratio is plotted along the ordinate while the ratio between the maximum widths d'_a and d_a (equal to 38 mm), along the abscissa. It is seen that the more the maximum width d'_a at the bend is narrowed, the higher the ratio I_B/I_A becomes, where I_B is the luminance at the point B in Fig. 6 while I_A, the luminance at the point A. The higher the ratio I_B/I_A, the more uniform the luminance distribution becomes. That is, when the maximum width d'_a at the bends is less than 0.85 times the maximum width d_a (equal to 38 mm in the experiments) of the straight portions, the very satisfactory luminance distribution can be attained. It is not needed to narrow the width of the bends throughout their length. The deflection of the arc becomes most pronounced at the point C (see Fig. 2) so that the width is most narrowed to d'_a at the point C and the width can be tapered gradually from d_a to d'_a. If the width d'_a is extremely narrowed, the luminance becomes higher at

the bends than along the straight portions. Furthermore, the outer appearance would become displeasing. Therefore, it is preferable that the maximum width d'_a at the bends is greater than 0.5 of the maximum width d_a of the straight portion.

In the first and second embodiments, the top portion of the lamp envelope is in the form of a dome, so that the bends with a downward concave are formed in the semispherical surface. Therefore, the deflection of the arc from the center line of the groove is less and the difference in luminance between the bends and the straight portions is less noticeable. The degree of deflection of the arc is dependent upon the radius of the semispherical surface. If the top portion of the lamp envelope is completely flat, the deflection of the arc will be almost avoided. It is preferable that the maximum width d'_a at the bends with a downward concave is wider than that at the bends with an upward concave.

The objects of the present invention can be attained only by making the maximum width of the bends with an upward concave narrower than that of the straight portions.

For the sake of the comparison of the present invention with the prior art, the fluorescent lamps with the groove as shown in Fig. 5 and the lamps of the construction as shown in Figs. 1A and 1B were fabricated. Their specifications and comparison results are shown in the Table below.

Table

	The Invention	*Prior Art*
Outer diameter ϕ (mm) of the outer bulb	75	75
Length L (mm) of the outer bulb	120	120
Distance l (mm) between the electrodes	410	370
Maximum width d_a (mm) of the straight portions of the groove	38	38
Maximum width d'_a (mm) of the bends with an upward concave	24	38
Maximum width d'_a (mm) of the bends with a downward concave	32	38
Depth d_b of the groove (mm)	16	16
Sealed gas and its pressure (Torr)	argon 2.5	argon 2.5
Lamp voltage (v)	50	50
Lamp efficacy (lm/W)	51	48
Non-uniform luminance distribution at the bends	None	Observed

In summary, according to the present invention, the problem that the luminance distribution is non-uniform at the bends of the groove or discharge path can be overcomed. In addition, the lamp efficacy can be improved.

Claims

1. A fluorescent lamp of the type wherein a lamp envelope comprises an outer bulb at least part of the wall of which is spherical or cylindrical and which has one open end, and an inner bulb nested in said outer bulb; at least either of said outer or inner bulb is formed with a continuous zig-zag groove which defines a discharge path; the surfaces of said groove which define said discharge path are coated with layers of phosphor; electrodes are disposed at the ends, respectively, of said groove; and said lamp envelope is filled with mercury and a rare gas; characterized in that the maximum width of the bends of said groove is narrower than the maximum width of the straight portions of said groove.

2. A fluorescent lamp as set forth in Claim 1 further characterized in that the following condition is satisfied

$$d'_a \leqq 0.85\, d_a$$

where d'_a is the maximum width of the bends with a concave upward and d_a is the maximum width of the straight portions of said groove.

3. A fluorescent lamp substantially as hereinbefore described, with reference to Figures 3 to 7 of the accompanying drawings.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1982. Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.